Claims:

1. Microorganism, characterized by the presence of a DNA sequence encoding a functional chaperone of a psychrophilic bacterium.
2. Microorganism according to claim 1, characterized in the DNA sequence encoding a functional chaperonin of a psychrophilic bacterium.
3. Microorganism according to claim 1, characterized in the DNA sequence encoding the chaperonin Cpn60 and/or Cpn 10 (SEQ ID No 1 and/or 2) of *Oleispira antarctica*.
4. Microorganism according to claim 1, characterized in the DNA sequence encoding a functional homolog of the chaperonin Cpn60 and/or Cpn10 of *Oleispira antarctica* (Seq ID Nr. 1 and/or 2) from a psychrophilic bacterium.
5. Microorganism according to claim 4, characterized in that the psychrophilic bacterium is selected from the group consisting of *Moraxella,* and *Alteromonas haloplanktis.*
6. Microorganism according to claim 1, characterized in the DNA sequence encoding a functional mutant of the chaperonin Cpn60 and/or Cpn 10 (Seq ID No 1 and/or 2) of *Oleispira antarctica*.
7. Microorganism according to claim 1, characterized in the DNA sequence encoding the stabilized single ring mutant chaperonin Glu461Ala/Ser463Ala/Val464Ala of Cpn60 (Seq ID No 11) or the mutant chaperonin Lys468Thr/Ser471Gly and/or Cpn 10.
8. Microorganism according to one of the preceding claims, which is selected among animal cell lines, plant cell lines, gram-positive or gram-negative bacteria, fungi and yeasts.
9. Microorganism according to one of the preceding claims, characterized in that the heterologous protein has enzymatic activity or hormonal activity in its native conformation.
10. Microorganism according to one of the preceding claims, characterized in that the DNA sequence encoding a functional chaperone is located chromosomally, extra-chromosomally, or mitochondrially, or in chloroplasts of plants.
11. Process for producing a protein by heterologous expression in a host microorganism containing a gene sequence encoding the heterologous protein, characterized in that a microorganism according to one of the preceding claims is used.
12. Process according to claim 11, characterized in that the host organism is cultivated at a temperature below 25 °C, preferably 4 to 15 °C.

13. Process according to claim 11 or 12, characterized in that the heterologous protein is selected from the group consisting of mammalian proteins, psychrophilic mammalian or bacterial proteins, mesophilic bacterial, fungal or yeast proteins, and mutant or fusion variants thereof.
14. Process for changing the conformation of denatured proteins into their native and/or active conformation, characterized by the step of contacting the denatured protein with a functional chaperone of a psychrophilic bacterium.
15. Process according to claim 14, characterized in that the chaperone is the chaperonin Cpn60 and/or Cpn 10 (Seq ID No 1 and/or 2) of *Oleispira antarctica* in presence of at least one nucleotide, preferably adenosine triphosphate.
16. Process according to claim 11, characterized in that the chaperone is a functional homolog of the chaperonin Cpn60 and/or Cpn 10 (Seq ID No 1 and/or 2) from a psychrophilic bacterium or a functional mutant of the chaperonin Cpn60 and/or Cpn 10 (Seq ID No 1 and/or 2) of *Oleispira antarctica*.
17. Process according to one of claims 11 to 16, characterized in that the contacting is performed extracellularly or *in vitro*.
18. Process according to claim 17, characterized in that the contacting uses at least one immobilized chaperone.
19. Plant, characterized in that it can grow at lower ambient temperatures due to the presence of a DNA sequence encoding a cold-active functional chaperone of a psychrophilic bacterium or plant.
20. Plant according to claim 19, characterized in the DNA sequence encoding a functional chaperonin selected from the group consisting of Cpn60 and/or Cpn 10 (SEQ ID No 1 and/or 2) of *Oleispira antarctica*, a functional homolog thereof, and the stabilized single ring mutant chaperonin Glu461Ala/Ser463Ala/Val464Ala of Cpn60 (Seq ID No 11).

Figure 1:

Amino acid sequences of Cpn60 and Cpn10:

SEQ ID No 1: Cpn10 (encoded by nucleotides pos. 458-751 of Figure 2):

MKIRPLHDRIVVRRKEEETATAGGIILPGAAAEKPNQGVVISVGTGRILDNGSVQALA
VNEGDVVVFGKYSGQNTIDIDGEELLILNESDIYGVLEA

SEQ ID No 2: Cpn60 (encoded by nucleotides pos. 800-2446 of Figure 2):

MAAKDVLFGDSARAKMLVGVNILADAVRVTLGPKGRNVVIEKSFGAPIITKDGVSV
AREIELKDKFENMGAQMVKEVASQANDQAGDGTTTATVLAQAIISEGLKSVAAGMN
PMDLKRGIDKATAAVVAAIKEQAQPCLDTKAIAQVGTISANADETVGRLIAEAMEKV
GKEGVITVEEGKGLEDELDVVEGMQFDRGYLSPYFINNQEKMTVEMENPLILLVDKK
IDNLQELLPILENVAKSGRPLLIVAEDVEGQALATLVVNNLRGTFKVAAVKAPGFGD
RRKAMLQDLAILTGGQVISEELGMSLETADPSSLGTASKVVIDKENTVIVDGAGTEAS
VNTRVDQIRAEIESSTSDYDIEKLQERVAKLAGGVAVIKVGAGSEMEMKEKKDRVD
DALHATRAAVEEGVVAGGGVALIRALSSVTVVGDNEDQNVGIALALRAMEAPIRQI
AGNAGAEGSVVVDKVKSGTGSFGFNASTGEYGDMIAMGILDPAKVTRSSLQAAASI
AGLMITTEAMVADAPVEEGAGGMPDMGGMGGMGGMPGMM

Figure 2:

SEQ ID No 3: DNA coding for Cpn60 and Cpn10:

Cpn10, pos. 458-751
Cpn60, pos. 800-2446

atcaaaaaatgcagcaaggacagattcctgcccaagaattagcagaaggtttcttgttagcactggccggcgctttattattaacgccgg
gttttgtcactgatgcgctgggttttacattactcgtccccgcgacgcgtaaagcgttggtccataaggtgattgcatttattacccctc
gcatgatgactgcaagcagctttcaagcgacgggtagttttcaggaaggctcgtttaaagatgtacattcgcacactgactcgcaaagca
gtcatgaaaaaatcacaattgaaggcgaatataccaaagacgataagtaggtatttttcggctagccgttgaaatcctagtaaaagccc

cgataaattaaccatctatttttcacagaggcaatttagcctttgtttaccttattgatcctaatacttgggatccaacagttggagagtctagc
aaatgaaaatccgtccattacatgatcgtattgttgttcgccgtaaagaagaagagaccgcaactgcgggtggtattatttacc
gggcgctgcggcagaaaaaccaaatcaaggtgttgttatctctgtgggtactggccgtattcttgataatggttcagtgcaagcgctggc
ggttaacgaaggcgatgttgtcgttttggtaaatactcaggtcaaaatactatcgatatcgatggtgaagaattattgattttgaatga
aagtgatatctacggcgttttagaagcttaattattacactcacttttttatttaacctacaaaatttaaggaaagatcatggctgctaaagacg
tattatttggtgatagcgcacgcgcaaaaatgttggtaggtgtaaacattttagccgacgcagtaagagttaccttaggacctaa
aggtcgtaacgttgttatagaaaaatcatttggtgcaccgatcatcaccaaagatggtgtttctgttgcgcgtgaaatcgaattgaaagaca
aattcgaaaacatgggcgcacagatggttaaggaagttgcttctcaagccaacgaccaagccggtgacggcacaacgacagcgact
gtactagcacaggcgattatcagcgaaggcttgaaatctgttgcggctggcatgaatccaatggatcttaaacgtggtattgataaagcta
cggctgctgttgttgccgccattaaagaacaagctcagccttgcttggatacaaaagcaatcgctcaggtagggacaatctctgccaatg
ccgatgaaacggttggtcgtttaattgctgaagcgatggaaaaagtcggtaaagaaggtgtgattaccgttgaagaaggcaaaggcctt
gaagacgagcttgatgttgtagaaggcatgcagttcgatcgcggttacttgtctccgtacttcatcaacaaccaagaaaaaatgaccgta
gaaatggaaaatccattaattctattggttgataagaaaattgataaccttcaagagctgttgccaattcttgaaaacgtcgctaaatcaggt
cgtccattattgatcgttgctgaagatgttgaaggccaagcactagcaacattggtagtaaacaacttgcgcggcacattcaaggttgc
agcggttaaagcccctggttttggcgatcgtcgtaaagcgatgttgcaagatcttgccatcttgacgggtggtcaggttatttctgaagag
ctagggatgtctttagaaactgcggatccttcttctttgggtacggcaagcaaggttgttatcgataaagaaaacaccgtgattgttga
tggcgcaggtactgaagcaagcgttaatactcgtgttgaccagatccgtgctgaaatcgaaagctcgacttctgattacgacatcgaaaa
gttacaagaacgcgttgctaagcttgcgggcggcgttgccgtgattaaggttggtgcgggttctgaaatggaaatgaaagagaagaaa
gaccgtgttgacgatgcacttcatgcaactcgcgcagcggttgaagaaggtgttgttgcgggtggtggtgttgctttgattcgcgcactct
cttcagtaaccgttgttggtgataacgaagatcaaaacgtcggtattgcattggcacttcgtgcgatggaagctcctatccgtcaaatcgc
gggtaacgcaggtgctgaagggtcagtggttgttgataaagtgaaatctggcacaggtagctttggttttaacgccagcacaggtgagt
atggcgatatgattgcgatgggtattttagaccctgcaaaagtcacgcgttcatctctacaagccgcggcgtctatcgcaggtttgatgat
cacaaccgaagccatggttgcggatgcgcctgttgaagaaggcgctggtggtatgcctgatatgggcggcatgggtggaatgggcg
gtatgcctggcatgatgtaatcactttgtgattcattgtcctgatctgcttaccgtgtaaaaagatcaggctcaaggctgtctctataaaaag
ccgtatctttgatgagtgttgtctttctgctgaaaacgacattcttggagtgcggctttttttgattttggtcataaaattcagaatattgtgtaatt
ttatgtaactagctggcctataatgttgagttcctctgggtggcatgatctcatggtacttcacttaagcctgattcactgcg
gctttaacagtaaaataataacgcaacgtagaaacataataagcgtatggcattaatgaagacggctgcatttaattcagatc

Figure 3:

SEQ ID No 4: Amino acid sequence of esterase cloned from *Oleispira antarctica* (EstRB8):

EstRB8 (encoded by nucleotides 1145 to 2143 Frame 2 of Figur 4) 333 aa

MKNTLKSSSRFSLKQLGTGALIISSLFFGGCTTTQQDNLYTGVMSLARDSAGLEVKTA
SAGDVNLTYMERQGSDKDNAESVILLHGFSADKDNWILFTKEFDEKYHVIAVDLAG
HGDSEQLLTTDYGLIKQAERLDIFLSGLGVNSFHIAGNSMGGAISAIYSLSHPEKVKSL
TLIDAAGVDGDTESEYYKVLAEGKNPLIATDEASFEYRMGFTMTQPPFLPWPLRPSLL
RKTLARAEINNKIFSDMLKTKERLGMTNFQQKIEVKMAQHPLPTLIMWGKEDRVLD
VSAAAAFKKIIPQATVHIFPEVGHLPMVEIPSESAKVYEEFLSSIK

Figure 4:

SEQ ID No 5: DNA fragment from plasmid pBK1Est coding for esterase of *Oleispira antarctica* (EstRB8):

Nucleotide positions 1-100 correspond to reverse complement of positions 1196-1121 and 3799-3939 correspond to reverse complement of 1043-952 of pBK-CMV vector (Stratagene).

Positions 101-105 are *BamH*I – *Sau*3A1 fusion and positions 3795-3798 are *Sau*3A1-*Bam*HI-fusion.

acaggaaacagctatgaccttgattacgccaagctcgaaattaaccctcactaaagggaacaaaagctggagctcgcgcgcctgcag
gtcgacactagtggatcaacggcgttcatggtactggctgagttcagcgtcataatgccgatgcgatactggccgtcatgactgagtact
tcttctgctagcaccgatttttctaatagcgcagcttcttttatttctgaacgggcaactgatgtagtttttttactaaccggcttttaggcatgg
taaactcttcgatattcaaaattattactgttcatattacaatcatagtacaggctagaggcccaaaattgcagctgatattcacctttattattc
taagcattattacactcatcgcggtgttattaattgtgctaaataaaaatacccgtagcggaaaaattcagcaaatagccaaagaaaacga
ttggcaataccaagaattcatcgattttgatgatgacattaagcaggcaaactttggcctattaaactacagtcaaaatgcaatttttagacat
ctcattcaagcaactgacgaacactatggcttagcgtttaagacctttgactgtcgagcgttagaaccttcaggtattcacaatagcagtct
tattttatttaccctcgcactaaagactgaattcaataacctacacatttgcttaagtcgacatattcaagataaagatgccttcactgacatca
gtcaccaacaatcaatcaaacaccaataccaatcgcaaaaactcataaaactagccgatcaccaaatcccaaaagcgttcaaaaatgaa
acgagcacgtcacacaaaatcaatttatacgctaacgaaccaggtcaaacttatcgtttttttgagcacgtttgttccactaatgaaagaga
aaagtcgttaattcactggcttttggcgtatccgcaccttcacatagaaattagtaatggcatgctactggcctttaaaaagaatcagttaatt
gaagaaacctcgcttatctcagccattaccgctgtagccgaatttgcgcttatcctcagccatgattaaactgacgccaattaatataagac
atactaattaataactcccttaattgagaagaataatgaaaaacacactcaaatcctcatcacgttttagtctgaaacaactcggcaccggc
gctctgattatctccagtttgttcttcggtggttgcaccacaacacaacaagataatttatacacaggggttatgtctcttgcgagagacagc
gctggcctagaagttaaaacagcctctgccggtgacgtcaatcttacttatatggaacgccaaggcagtgacaaagataatgccgaaag

cgttattttattacacggtttctctgctgataaagataactggattctttttaccaaagaattcgatgaaaaatatcatgttatcgctgtcgattta
gcgggacatggcgattcagaacaattattaacgactgattacggtctcataaaacaagccgagcgtttagatatcttcttatctggcttagg
ggttaactcatttcacatcgccggtaattcaatgggggggctatcagcgcaatctacagtttgagtcacccagagaaagttaaaagtctt
acattgatcgatgcagcaggtgtcgatggcgatactgaaagcgaatactacaaagttttggcagaaggtaagaatcctttaattgcaact
gatgaagcaagttttgaataccgcatgggtttcaccatgactcagcctcctttcctaccttggccactaagaccttctttattacgtaaaacg
ctagcccgtgccgagatcaataacaaaatttttttccgatatgctgaaaaccaaagaacgtttaggaatgactaactttcaacagaaaattg
aagtgaaaatggctcaacatccattgccaacactgattatgtggggcaaagaagatcgcgttcttgacgtatccgcagcagcggccttc
aaaaaaataattccacaagcaactgttcatatttttcctgaagtaggccacctacctatggtagaaattcctagtgaaagcgctaaagtttat
gaagagtttttgtcctctattaaataagagcacataatcatgactgacttataaacagccaagcatttaaaatgcttggctgtttatttttaatgg
ccaaattattcaacgaccaagctctgcggtaaaatcgcagtgggtttcttgttttcatcaacagcaacaaacgtgaaataccccgtaatcg
cattttctgattatcaaaatacatactttccaccagcatattaacttcaacttttaaactcgtccgccctacctctataacactggcagtcaatt
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gcaataaaagaaacctcatccatccactgcattgcagtgccaccgaataacgtatcatgatgatttgttgtctctggaaataccgctttaga
aatagtggtttttgatacgcgctttcgctgcgcaataatatcttctctgctaagagttgcggatggcatacataaactcgcttgattaagatta
ataataaatagttaacagtatattgaactgagggtctgaagaactctaatacctctgaagaactttgaggccgctagagagaaaagacca
gtgataatatttcatcttgccatgagagcttatcatgaaagcctgtgcttaaaatcaatcattatatttattcatctttaattgaaataataccaat
atatttcatatataatttcacactacccttatctcactagacttcccgcgcataggcgcaaacaatcaacgcaagttcacaataaagcggttc
gctgcaacacatgccctagcgtctaaagtagcacgcacaacactggccagtcgtactagccccttgcgattcgtgcagacgagcaac
aagcgctattaaacttacctaaatttctaaccaccaccattggttcttttccacaaactcaaaaaactcgtcaaatccgcttgcaatttaaacg
cgatgacatagatctaatcgattatcaaacccgcattcaagcgctcattaaaaacgcaccactggcaagaagttctacctgcactgacca
atatgcaagcggcggcggaagagctgcctttgatcgatcaagaagaagggagcagcaaagaggaaaacaatcaaaaagaggaga
gcaatcaaataaaaacgagttattgaggattttaattttaaaacaggtatattaataccctctctcgtagtaaacaatgactgtatttacacaa
aaataaatagaggtataccatgtcaaacatctggtttgaagtaccaaagattgaagtattaaaccgtcaaatggaaaatactgcctgcagc
aacttaggcattcaaattacagaaattggcgatgattatatcactggcacaatgccagcagatgcacgtaccttccagccaatgggactg
attcatggcggctcaaatgtattgctggcagaaacactgggcagcatggcagctaactgctgtattaatttgtctcaagaatattgtgttgg
ccaagaaattaacgccaaccacatacgcggtgttcgttccggcatagtgactggcacagcaacgctagtacacaaaggaagaacctc
ccagatttgggaaattcgcatcgttaacgatccaaagaattcaaaaagcttctcgagagtacttctagagcggccgcgggcccatcgatt
ttccacccgggtggggtaccaggtaagtgtacccaattcgccctatagtgagtcgtattacaattcactggccgtcgttttac

Figure 5:

Amino acid sequences expressed from vector pBK1CpnEst: - the co-expression of fragments encoding native chaperonines with the esterase gene (EstRB8), all from *Oleispira antarctica*

SEQ ID No 6: cpn10 (nucleotides 113 to 403: Frame 2 of Figure 6) 97 aa:

MKIRPLHDRIVVRRKEEETATAGGIILPGAAAEKPNQGVVISVGTGRILDNGSVQALA
VNEGDVVVFGKYSGQNTIDIDGEELLILNESDIYGVLEA

SEQ ID No 7: cpn60 (nucleotides 455 to 2098: Frame 2 of Figure 6) 548 aa:

MAAKDVLFGDSARAKMLVGVNILADAVRVTLGPKGRNVVIEKSFGAPIITKDGVSV
AREIELKDKFENMGAQMVKEVASQANDQAGDGTTTATVLAQAIISEGLKSVAAGMN
PMDLKRGIDKATAAVVAAIKEQAQPCLDTKAIAQVGTISANADETVGRLIAEAMEKV
GKEGVITVEEGKGLEDELDVVEGMQFDRGYLSPYFINNQEKMTVEMENPLILLVDKK
IDNLQELLPILENVAKSGRPLLIVAEDVEGQALATLVVNNLRGTFKVAAVKAPGFGD
RRKAMLQDLAILTGGQVISEELGMSLETADPSSLGTASKVVIDKENTVIVDGAGTEAS
VNTRVDQIRAEIESSTSDYDIEKLQERVAKLAGGVAVIKVGAGSEMEMKEKKDRVD
DALHATRAAVEEGVVAGGGVALIRALSSVTVVGDNEDQNVGIALALRAMEAPIRQI
AGNAGAEGSVVVDKVKSGTGSFGFNASTGEYGDMIAMGILDPAKVTRSSLQAAASI
AGLMITTEAMVADAPVEEGAGGMPDMGGMGGMGGMPGMM

SEQ ID No 8: estRB8 (nucleotides 2579 to 3577: Frame 2 of Figure 6) 333 aa:

MKNTLKSSSRFSLKQLGTGALIISSLFFGGCTTTQQDNLYTGVMSLARDSAGLEVKTA
SAGDVNLTYMERQGSDKDNAESVILLHGFSADKDNWILFTKEFDEKYHVIAVDLAG
HGDSEQLLTTDYGLIKQAERLDIFLSGLGVNSFHIAGNSMGGAISAIYSLSHPEKVKSL
TLIDAAGVDGDTESEYYKVLAEGKNPLIATDEASFEYRMGFTMTQPPFLPWPLRPSLL
RKTLARAEINNKIFSDMLKTKERLGMTNFQQKIEVKMAQHPLPTLIMWGKEDRVLD
VSAAAAFKKIIPQATVHIFPEVGHLPMVEIPSESAKVYEEFLSSIK

Figure 6:

SEQ ID No 9: pBK1CpnEst: - the fusion of native chaperonine-coding fragments with esterase of *Oleispira antarctica* (EstRB8)

The DNA fragment coding for Cpn10 and Cpn60 is flanked by *Sac*I site (pos. 69-75) and *Sal*I site (encoded by pos. 2138-2143 of Figure 7):

Nucleotide positions 1-75 correspond to reverse complement of positions 1196-1121 and positions 5233-5273 correspond to reverse complement of 1043-952 of pBK-CMV vector (Stratagene)

Small letters – the Cpn10-Cpn60 encoding fragment,
Capital italics – fragments of vector pBK-CMV
Capital letters – fragment coding for EstRB8 from plasmid pBK1Est

ACAGGAAACAGCTATGACCTTGATTACGCCAAGCTCGAAATTAACCCTCACTAAAGGGA
*ACAAAAGCTGGAGCTC*ctaatacttgggatccaacagttggagagtctagcaaatgaaaatccgtccattacatgatcgtatt
gttgttcgccgtaaagaagaagagaccgcaactgcgggtggtattattttaccgggcgctgcggcagaaaaaccaaatcaaggtgttgt
tatctctgtgggtactggccgtattcttgataatggttcagtgcaagcgctggcggttaacgaaggcgatgttgtcgtttttggtaaatactc
aggtcaaaatactatcgatatcgatggtgaagaattattgattttgaatgaaagtgatatctacggcgttttagaagcttaattattacactca
ctttttttatttaacctacaaaatttaaggaaagatcatggctgctaaagacgtattatttggtgatagcgcacgcgcaaaaatgttggtaggt
gtaaacattttagccgacgcagtaagagttaccttaggacctaaaggtcgtaacgttgttatagaaaaatcatttggtgcaccgatcatcac
caaagatggtgtttctgttgcgcgtgaaatcgaattgaaagacaaattcgaaaacatgggcgcacagatggttaaggaagttgcttctca
agccaacgaccaagccggtgacggcacaacgacagcgactgtactagcacaggcgattatcagcgaaggcttgaaatctgttgcgg
ctggcatgaatccaatggatcttaaacgtggtattgataaagctacggctgctgttgttgccgccattaaagaacaagctcagccttgcttg
gatacaaaagcaatcgctcaggtagggacaatctctgccaatgccgatgaaacggttggtcgtttaattgctgaagcgatggaaaaagt
cggtaaagaaggtgtgattaccgttgaagaaggcaaaggccttgaagacgagcttgatgttgtagaaggcatgcagttcgatcgcggtt
acttgtctccgtacttcatcaacaaccaagaaaaaatgaccgtagaaatggaaaatccattaattctattggttgataagaaaattgataac
cttcaagagctgttgccaattcttgaaaacgtcgctaaatcaggtcgtccattattgatcgttgctgaagatgttgaaggccaagcactagc
aacattggtagtaaacaacttgcgcggcacattcaaggttgcagcggttaaagcccctggttttggcgatcgtcgtaaagcgatgttgca
agatcttgccatcttgacgggtggtcaggttatttctgaagagctagggatgtctttagaaactgcggatccttcttctttgggtacggcaa
gcaaggttgttatcgataaagaaaacaccgtgattgttgatggcgcaggtactgaagcaagcgttaatactcgtgttgaccagatccgtg
ctgaaatcgaaagctcgacttctgattacgacatcgaaaagttacaagaacgcgttgctaagcttgcgggcggcgttgccgtgattaag

gttggtgcgggttctgaaatggaaatgaaagagaagaaagaccgtgttgacgatgcacttcatgcaactcgcgcagcggttgaagaag
gtgttgttgcgggtggtggtgttgctttgattcgcgcactctcttcagtaaccgttgttggtgataacgaagatcaaaacgtcggtattgcat
tggcacttcgtgcgatggaagctcctatccgtcaaatcgcgggtaacgcaggtgctgaagggtcagtggttgttgataaagtgaaatctg
gcacaggtagctttggttttaacgccagcacaggtgagtatggcgatatgattgcgatgggtattttagaccctgcaaaagtcacgcgttc
atctctacaagccgcggcgtctatcgcaggtttgatgatcacaaccgaagccatggttgcggatgcgcctgttgaagaaggcgctggtg
gtatgcctgatatgggcggcatgggtggaatgggcggtatgcctggcatgatgtaatcactttgtgattcattgtcctgatctgcttaccgt
GTCGACATATTCAAGATAAAGATGCCTTCACTGACATCAGTCACCAACAATCAAT
CAAACACCAATACCAATCGCAAAAACTCATAAAACTAGCCGATCACCAAATCCC
AAAAGCGTTCAAAAATGAAACGAGCACGTCACACAAAATCAATTTATACGCTAA
CGAACCAGGTCAAACTTATCGTTTTTTTGAGCACGTTTGTTCCACTAATGAAAGA
GAAAAGTCGTTAATTCACTGGCTTTTGGCGTATCCGCACCTTCACATAGAAATTA
GTAATGGCATGCTACTGGCCTTTAAAAAGAATCAGTTAATTGAAGAAACCTCGCT
TATCTCAGCCATTACCGCTGTAGCCGAATTTGCGCTTATCCTCAGCCATGATTAAA
CTGACGCCAATTAATATAAGACATACTAATTAATAACTCCCTTAATTGAGAAGAA
TAATGAAAAACACACTCAAATCCTCATCACGTTTTAGTCTGAAACAACTCGGCAC
CGGCGCTCTGATTATCTCCAGTTTGTTCTTCGGTGGTTGCACCACAACACAACAAG
ATAATTTATACACAGGGGTTATGTCTCTTGCGAGAGACAGCGCTGGCCTAGAAGT
TAAAACAGCCTCTGCCGGTGACGTCAATCTTACTTATATGGAACGCCAAGGCAGT
GACAAAGATAATGCCGAAAGCGTTATTTTATTACACGGTTTCTCTGCTGATAAAG
ATAACTGGATTCTTTTTACCAAAGAATTCGATGAAAAATATCATGTTATCGCTGTC
GATTTAGCGGGACATGGCGATTCAGAACAATTATTAACGACTGATTACGGTCTCA
TAAAACAAGCCGAGCGTTTAGATATCTTCTTATCTGGCTTAGGGGTTAACTCATTT
CACATCGCCGGTAATTCAATGGGGGGGGCTATCAGCGCAATCTACAGTTTGAGTC
ACCCAGAGAAAGTTAAAAGTCTTACATTGATCGATGCAGCAGGTGTCGATGGCG
ATACTGAAAGCGAATACTACAAAGTTTTGGCAGAAGGTAAGAATCCTTTAATTGC
AACTGATGAAGCAAGTTTTGAATACCGCATGGGTTTCACCATGACTCAGCCTCCT
TTCCTACCTTGGCCACTAAGACCTTCTTTATTACGTAAAACGCTAGCCCGTGCCGA
GATCAATAACAAAATTTTTTCCGATATGCTGAAAACCAAAGAACGTTTAGGAATG
ACTAACTTTCAACAGAAAATTGAAGTGAAAATGGCTCAACATCCATTGCCAACAC
TGATTATGTGGGGCAAAGAAGATCGCGTTCTTGACGTATCCGCAGCAGCGGCCTT
CAAAAAAATAATTCCACAAGCAACTGTTCATATTTTTCCTGAAGTAGGCCACCTA
CCTATGGTAGAAATTCCTAGTGAAAGCGCTAAAGTTTATGAAGAGTTTTTGTCCT
CTATTAAATAAGAGCACATAATCATGACTGACTTATAAACAGCCAAGCATTTAAA
ATGCTTGGCTGTTTATTTTAATGGCCAAATTATTCAACGACCAAGCTCTGCGGTAA

AATCGCAGTGGGTTTCTTGTTTTCATCAACAGCAACAAACGTGAAATACCCCGTA
ATCGCATTTTTCTGATTATCAAAATACATACTTTCCACCAGCATATTAACTTCAAC
TTTTAAACTCGTCCGCCCTACCTCTATAACACTGGCAGTCAATTCGACAATGGTAC
CTGCGGGAACAGGATGCTTAAAATCGATTCGATCACTGCTGACGGTTACGATGCT
TTGTCGAGAAAAACGAGTCGCTGCAATAAAAGAAACCTCATCCATCCACTGCATT
GCAGTGCCACCGAATAACGTATCATGATGATTTGTTGTCTCTGGAAATACCGCTTT
AGAAATAGTGGTTTTTGATACGCGCTTTCGCTGCGCAATAATATCTTCTCTGCTAA
GAGTTGCGGATGGCATACATAAACTCGCTTGATTAAGATTAATAATAAATAGTTA
ACAGTATATTGAACTGAGGGTCTGAAGAACTCTAATACCTCTGAAGAACTTTGAG
GCCGCTAGAGAGAAAAGACCAGTGATAATATTTCATCTTGCCATGAGAGCTTATC
ATGAAAGCCTGTGCTTAAAATCAATCATTATATTTATTCATCTTTAATTGAAATAA
TACCAATATATTTCATATATAATTTCACACTACCCTTATCTCACTAGACTTCCCGC
GCATAGGCGCAAACAATCAACGCAAGTTCACAATAAAGCGGTTCGCTGCAACAC
ATGCCCTAGCGTCTAAAGTAGCACGCACAACACTGGCCAGTCGTACTAGCCCCTT
TGCGATTCGTGCAGACGAGCAACAAGCGCTATTAAACTTACCTAAATTTCTAACC
ACCACCATTGGTTCTTTTCCACAAACTCAAAAAACTCGTCAAATCCGCTTGCAATT
TAAACGCGATGACATAGATCTAATCGATTATCAAACCCGCATTCAAGCGCTCATT
AAAAACGCACCACTGGCAAGAAGTTCTACCTGCACTGACCAATATGCAAGCGGC
GGCGGAAGAGCTGCCTTTGATCGATCAAGAAGAAGGGAGCAGCAAAGAGGAAA
ACAATCAAAAAGAGGAGAGCAATCAAATAAAAACGAGTTATTGAGGATTTTAAT
TTTAAAACAGGTATATTAATACCCTCTCTCGTAGTAAACAATGACTGTATTTACAC
AAAAATAAATAGAGGTATACCATGTCAAACATCTGGTTTGAAGTACCAAAGATTG
AAGTATTAAACCGTCAAATGGAAAATACTGCCTGCAGCAACTTAGGCATTCAAAT
TACAGAAATTGGCGATGATTATATCACTGGCACAATGCCAGCAGATGCACGTACC
TTCCAGCCAATGGGACTGATTCATGGCGGCTCAAATGTATTGCTGGCAGAAACAC
TGGGCAGCATGGCAGCTAACTGCTGTATTAATTTGTCTCAAGAATATTGTGTTGG
CCAAGAAATTAACGCCAACCACATACGCGGTGTTCGTTCCGGCATAGTGACTGGC
ACAGCAACGCTAGTACACAAAGGAAGAACCTCCCAGATTTGGGAAATTCGCATC
GTTAAC*GATCCAAAGAATTCAAAAAGCTTCTCGAGAGTACTTCTAGAGCGGCCGCGGG*
CCCATCGATTTTCCACCCGGGTGGGGTACCAGGTAAGTGTACCCAATTCGCCCTATAGT
GAGTCGTATTACAATTCACTGGCCGTCGTTTTAC

Figure 7:

Amino acid sequences expressed from vector pBK1CpnSREst: - the co-expression of the stabilized single ring mutant chaperonin with the esterase gene (EstRB8) from *Oleispira antarctica* (cpn10::stabilized single ring mutant Glu461Ala/Ser463Ala/Val464Ala::est)

SEQ ID No 10: cpn10 (nucleotides 113 to 403: Frame 2 of Figure 8) 97 aa:

MKIRPLHDRIVVRRKEEETATAGGIILPGAAAEKPNQGVVISVGTGRILDNGSVQALA
VNEGDVVVFGKYSGQNTIDIDGEELLILNESDIYGVLEA

Below – ***Capital bold letters*** are the mutations introduced

SEQ ID No 11: stabilized single ring mutant of cpn60 (nucleotides 455 to 2098: Frame 2 of Figure 8) 548 aa:

MAAKDVLFGDSARAKMLVGVNILADAVRVTLGPKGRNVVIEKSFGAPIITKDGVSV
AREIELKDKFENMGAQMVKEVASQANDQAGDGTTTATVLAQAIISEGLKSVAAGMN
PMDLKRGIDKATAAVVAAIKEQAQPCLDTKAIAQVGTISANADETVGRLIAEAMEKV
GKEGVITVEEGKGLEDELDVVEGMQFDRGYLSPYFINNQEKMTVEMENPLILLVDKK
IDNLQELLPILENVAKSGRPLLIVAEDVEGQALATLVVNNLRGTFKVAAVKAPGFGD
RRKAMLQDLAILTGGQVISEELGMSLETADPSSLGTASKVVIDKENTVIVDGAGTEAS
VNTRVDQIRAEIESSTSDYDIEKLQERVAKLAGGVAVIKVGAGSEMEMKEKKDRVD
DALHATRAAVEEGVVAGGGVALIRALSSVTVVGDNEDQNVGIALALRAMEAPIRQI
AGNAGAAGAAVVDKVKSGTGSFGFNASTGEYGDMIAMGILDPAKVTRSSLQAAASI
AGLMITTEAMVADAPVEEGAGGMPDMGGMGGMGGMPGMM

SEQ ID No 12: EstRB8 (nucleotides 2579 to 3577: Frame 2 of Figure 8) 333 aa:

MKNTLKSSSRFSLKQLGTGALIISSLFFGGCTTTQQDNLYTGVMSLARDSAGLEVKTA
SAGDVNLTYMERQGSDKDNAESVILLHGFSADKDNWILFTKEFDEKYHVIAVDLAG
HGDSEQLLTTDYGLIKQAERLDIFLSGLGVNSFHIAGNSMGGAISAIYSLSHPEKVKSL
TLIDAAGVDGDTESEYYKVLAEGKNPLIATDEASFEYRMGFTMTQPPFLPWPLRPSLL

RKTLARAEINNKIFSDMLKTKERLGMTNFQQKIEVKMAQHPLPTLIMWGKEDRVLD
VSAAAAFKKIIPQATVHIFPEVGHLPMVEIPSESAKVYEEFLSSIK

Figure 8:

SEQ ID No 13: DNA sequence of vector pBK1CpnSREst: the expression cassette for the co-expression of the stabilized single ring mutant chaperonin with the esterase gene (EstRB8) from *Oleispira antarctica* (cpn10::stabilized single ring mutant Glu461Ala/Ser463Ala/Val464Ala::est)

Nucleotide positions 1-75 correspond to reverse complement of positions 1196-1121 and positions 5233-5273 correspond to reverse complement of 1043-952 of pBK-CMV vector (Stratagene)

DNA fragment coding for Cpn10 and Cpn60 is flanked by *Sac*I site (pos. 69-75) and *Sal*I site (pos. 2138-2143).

In the DNA sequence:
Small letters – the Cpn10-Cpn60 coding fragment,
Capital italics – fragments of vector
Capital letters – fragment coding for EstRB8 from plasmid pBK1Est
Capital bold letters = introduced mutations

ACAGGAAACAGCTATGACCTTGATTACGCCAAGCTCGAAATTAACCCTCACTAAAGGGA
*ACAAAAGCTGGAGCTC*ctaatacttgggatccaacagttggagagtctagcaaatgaaaatccgtccattacatgatcgtatt
gttgttcgccgtaaagaagaagagaccgcaactgcgggtggtattattttaccgggcgctgcggcagaaaaaccaaatcaaggtgttgt
tatctctgtgggtactggccgtattcttgataatggttcagtgcaagcgctggcggttaacgaaggcgatgttgtcgtttttggtaaatactc
aggtcaaaatactatcgatatcgatggtgaagaattattgattttgaatgaaagtgatatctacggcgttttagaagcttaattattacactca
ctttttatttaacctacaaaatttaaggaaagatcatggctgctaaagacgtattatttggtgatagcgcacgcgcaaaaatgttggtaggt
gtaaacattttagccgacgcagtaagagttaccttaggacctaaaggtcgtaacgttgttatagaaaaatcatttggtgcaccgatcatcac
caaagatggtgtttctgttgcgcgtgaaatcgaattgaaagacaaattcgaaaacatgggcgcacagatggttaaggaagttgcttctca
agccaacgaccaagccggtgacggcacaacgacagcgactgtactagcacaggcgattatcagcgaaggcttgaaatctgttgcgg
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gatacaaaagcaatcgctcaggtagggacaatctctgccaatgccgatgaaacggttggtcgtttaattgctgaagcgatggaaaaagt
cggtaaagaaggtgtgattaccgttgaagaaggcaaaggccttgaagacgagcttgatgttgtagaaggcatgcagttcgatcgcggtt
acttgtctccgtacttcatcaacaaccaagaaaaaatgaccgtagaaatggaaaatccattaattctattggttgataagaaaattgataac
cttcaagagctgttgccaattcttgaaaacgtcgctaaatcaggtcgtccattattgatcgttgctgaagatgttgaaggccaagcactagc
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agatcttgccatcttgacgggtggtcaggttatttctgaagagctagggatgtctttagaaactgcggatccttcttctttgggtacggcaa
gcaaggttgttatcgataaagaaaacaccgtgattgttgatggcgcaggtactgaagcaagcgttaatactcgtgttgaccagatccgtg
ctgaaatcgaaagctcgacttctgattacgacatcgaaaagttacaagaacgcgttgctaagcttgcgggcggcgttgccgtgattaag
gttggtgcgggttctgaaatggaaatgaaagagaagaaagaccgtgttgacgatgcacttcatgcaactcgcgcagcggttgaagaag
gtgttgttgcgggtggtggtgttgctttgattcgcgcactctcttcagtaaccgttgttggtgataacgaagatcaaaacgtcggtattgcat
tggcacttcgtgcgatggaagctcctatccgtcaaatcgcgggtaacgcaggtgctgCagggGcagCggttgttgataaagtgaaat
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gttcatctctacaagccgcggcgtctatcgcaggtttgatgatcacaaccgaagccatggttgcggatgcgcctgttgaagaaggcgct
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ccgtGTCGACATATTCAAGATAAAGATGCCTTCACTGACATCAGTCACCAACAATC
AATCAAACACCAATACCAATCGCAAAAACTCATAAAACTAGCCGATCACCAAAT
CCCAAAAGCGTTCAAAAATGAAACGAGCACGTCACACAAAATCAATTTATACGC
TAACGAACCAGGTCAAACTTATCGTTTTTTTGAGCACGTTTGTTCCACTAATGAAA
GAGAAAAGTCGTTAATTCACTGGCTTTTGGCGTATCCGCACCTTCACATAGAAAT
TAGTAATGGCATGCTACTGGCCTTTAAAAAGAATCAGTTAATTGAAGAAACCTCG
CTTATCTCAGCCATTACCGCTGTAGCCGAATTTGCGCTTATCCTCAGCCATGATTA
AACTGACGCCAATTAATATAAGACATACTAATTAATAACTCCCTTAATTGAGAAG
AATAATGAAAAACACACTCAAATCCTCATCACGTTTTAGTCTGAAACAACTCGGC
ACCGGCGCTCTGATTATCTCCAGTTTGTTCTTCGGTGGTTGCACCACAACACAACA
AGATAATTTATACACAGGGGTTATGTCTCTTGCGAGAGACAGCGCTGGCCTAGAA
GTTAAAACAGCCTCTGCCGGTGACGTCAATCTTACTTATATGGAACGCCAAGGCA
GTGACAAAGATAATGCCGAAAGCGTTATTTTATTACACGGTTTCTCTGCTGATAA
AGATAACTGGATTCTTTTTACCAAAGAATTCGATGAAAAATATCATGTTATCGCT
GTCGATTTAGCGGGACATGGCGATTCAGAACAATTATTAACGACTGATTACGGTC
TCATAAAACAAGCCGAGCGTTTAGATATCTTCTTATCTGGCTTAGGGGTTAACTC
ATTTCACATCGCCGGTAATTCAATGGGGGGGGCTATCAGCGCAATCTACAGTTTG
AGTCACCCAGAGAAAGTTAAAAGTCTTACATTGATCGATGCAGCAGGTGTCGATG
GCGATACTGAAAGCGAATACTACAAAGTTTTGGCAGAAGGTAAGAATCCTTTAAT
TGCAACTGATGAAGCAAGTTTTGAATACCGCATGGGTTTCACCATGACTCAGCCT

CCTTTCCTACCTTGGCCACTAAGACCTTCTTTATTACGTAAAACGCTAGCCCGTGC
CGAGATCAATAACAAAATTTTTTCCGATATGCTGAAAACCAAAGAACGTTTAGGA
ATGACTAACTTTCAACAGAAAATTGAAGTGAAAATGGCTCAACATCCATTGCCAA
CACTGATTATGTGGGGCAAAGAAGATCGCGTTCTTGACGTATCCGCAGCAGCGGC
CTTCAAAAAAATAATTCCACAAGCAACTGTTCATATTTTTCCTGAAGTAGGCCAC
CTACCTATGGTAGAAATTCCTAGTGAAAGCGCTAAAGTTTATGAAGAGTTTTTGT
CCTCTATTAAATAAGAGCACATAATCATGACTGACTTATAAACAGCCAAGCATTT
AAAATGCTTGGCTGTTTATTTTAATGGCCAAATTATTCAACGACCAAGCTCTGCG
GTAAAATCGCAGTGGGTTTCTTGTTTTCATCAACAGCAACAAACGTGAAATACCC
CGTAATCGCATTTTTCTGATTATCAAAATACATACTTTCCACCAGCATATTAACTT
CAACTTTTAAACTCGTCCGCCCTACCTCTATAACACTGGCAGTCAATTCGACAATG
GTACCTGCGGGAACAGGATGCTTAAAATCGATTCGATCACTGCTGACGGTTACGA
TGCTTTGTCGAGAAAAACGAGTCGCTGCAATAAAAGAAACCTCATCCATCCACTG
CATTGCAGTGCCACCGAATAACGTATCATGATGATTTGTTGTCTCTGGAAATACC
GCTTTAGAAATAGTGGTTTTTGATACGCGCTTTCGCTGCGCAATAATATCTTCTCT
GCTAAGAGTTGCGGATGGCATACATAAACTCGCTTGATTAAGATTAATAATAAAT
AGTTAACAGTATATTGAACTGAGGGTCTGAAGAACTCTAATACCTCTGAAGAACT
TTGAGGCCGCTAGAGAGAAAAGACCAGTGATAATATTTCATCTTGCCATGAGAGC
TTATCATGAAAGCCTGTGCTTAAAATCAATCATTATATTTATTCATCTTTAATTGA
AATAATACCAATATATTTCATATATAATTTCACACTACCCTTATCTCACTAGACTT
CCCGCGCATAGGCGCAAACAATCAACGCAAGTTCACAATAAAGCGGTTCGCTGC
AACACATGCCCTAGCGTCTAAAGTAGCACGCACAACACTGGCCAGTCGTACTAGC
CCCTTTGCGATTCGTGCAGACGAGCAACAAGCGCTATTAAACTTACCTAAATTTC
TAACCACCACCATTGGTTCTTTTCCACAAACTCAAAAAACTCGTCAAATCCGCTTG
CAATTTAAACGCGATGACATAGATCTAATCGATTATCAAACCCGCATTCAAGCGC
TCATTAAAAACGCACCACTGGCAAGAAGTTCTACCTGCACTGACCAATATGCAAG
CGGCGGCGGAAGAGCTGCCTTTGATCGATCAAGAAGAAGGGAGCAGCAAAGAGG
AAAACAATCAAAAAGAGGAGAGCAATCAAATAAAAACGAGTTATTGAGGATTTT
AATTTTAAAACAGGTATATTAATACCCTCTCTCGTAGTAAACAATGACTGTATTTA
CACAAAAATAAATAGAGGTATACCATGTCAAACATCTGGTTTGAAGTACCAAAG
ATTGAAGTATTAAACCGTCAAATGGAAAATACTGCCTGCAGCAACTTAGGCATTC
AAATTACAGAAATTGGCGATGATTATATCACTGGCACAATGCCAGCAGATGCACG
TACCTTCCAGCCAATGGGACTGATTCATGGCGGCTCAAATGTATTGCTGGCAGAA
ACACTGGGCAGCATGGCAGCTAACTGCTGTATTAATTTGTCTCAAGAATATTGTG

TTGGCCAAGAAATTAACGCCAACCACATACGCGGTGTTCGTTCCGGCATAGTGAC
TGGCACAGCAACGCTAGTACACAAAGGAAGAACCTCCCAGATTTGGGAAATTCG
CATCGTTAAC*GATCCAAAGAATTCAAAAAGCTTCTCGAGAGTACTTCTAGAGCGGCCG*
CGGGCCCATCGATTTTCCACCCGGGTGGGGTACCAGGTAAGTGTACCCAATTCGCCCT
ATAGTGAGTCGTATTACAATTCACTGGCCGTCGTTTTAC

Figure 9:

Amino acid sequence of the stabilized single ring mutant Glu461Ala/Ser463Ala/Val464Ala of Cpn60:

SEQ ID No 14: Cpn10 (nucleotides 458-751of Figure 10):

MKIRPLHDRIVVRRKEEETATAGGIILPGAAAEKPNQGVVISVGTGRILDNGSVQALA
VNEGDVVVFGKYSGQNTIDIDGEELLILNESDIYGVLEA

SEQ ID No 15: Cpn60 (nucleotides 458-751 of Figure 10):

MAAKDVLFGDSARAKMLVGVNILADAVRVTLGPKGRNVVIEKSFGAPIITKDGVSV
AREIELKDKFENMGAQMVKEVASQANDQAGDGTTTATVLAQAIISEGLKSVAAGMN
PMDLKRGIDKATAAVVAAIKEQAQPCLDTKAIAQVGTISANADETVGRLIAEAMEKV
GKEGVITVEEGKGLEDELDVVEGMQFDRGYLSPYFINNQEKMTVEMENPLILLVDKK
IDNLQELLPILENVAKSGRPLLIVAEDVEGQALATLVVNNLRGTFKVAAVKAPGFGD
RRKAMLQDLAILTGGQVISEELGMSLETADPSSLGTASKVVIDKENTVIVDGAGTEAS
VNTRVDQIRAEIESSTSDYDIEKLQERVAKLAGGVAVIKVGAGSEMEMKEKKDRVD
DALHATRAAVEEGVVAGGGVALIRALSSVTVVGDNEDQNVGIALALRAMEAPIRQI
AGNAGAAGAAVVDKVKSGTGSFGFNASTGEYGDMIAMGILDPAKVTRSSLQAAASI
AGLMITTEAMVADAPVEEGAGGMPDMGGMGGMGGMPGMM

Figure 10:

SEQ ID No 16: DNA sequence of the stabilized single ring mutant Glu461Ala/Ser463Ala/Val464Ala:

In the DNA sequence:
Small letters – the Cpn10-Cpn60 coding fragment,
Big bold letters = introduced mutations

atcaaaaaatgcagcaaggacagattcctgcccaagaattagcagaaggtttcttgttagcactggccggcgctttattattaacgccgg
gttttgtcactgatgcgctgggttttacattactcgtccccgcgacgcgtaaagcgttggtccataaggtgattgcatttattacccctc
gcatgatgactgcaagcagctttcaagcgacgggtagttttcaggaaggctcgtttaaagatgtacattcgcacactgactcgcaaagca
gtcatgaaaaaatcacaattgaaggcgaatataccaaagacgataagtaggtatttttcggctagccgttgaaatcctagtaaaagccc
cgataaattaaccatctatttttcacagaggcaatttagcctttgtttaccttattgatcctaatacttgggatccaacagttggagagtctagc
aaatgaaaatccgtccattacatgatcgtattgttgttcgccgtaaagaagaagagaccgcaactgcgggtggtattattttacc
gggcgctgcggcagaaaaaccaaatcaaggtgttgttatctctgtgggtactggccgtattcttgataatggttcagtgcaagcgctggc
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attttatgtaactagctggcctataatgttgagttcctctgggtggcatgatctcatggtacttcacttaagcctgattcactgcg
gctttaacagtaaaataataacgcaacgtagaaacataataagcgtatggcattaatgaagacggctgcatttaattcagatc